Minos Far Detector Grounding Proposal[1]

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Electronics Racks will house the Readout Board Mini-Crate, the HV power crate, and low voltage power supplies for the Front End Board. There will be sixteen such racks, each of which services four Mux-Box Racks as shown in Fig. 1. There will be a **Global Ground** defined by a copper bar or large copper braid which connects the Electronics Racks together laterally as shown also in Fig. 1. The Global Ground may also be connected to Earth (embedded copper rod) at one point for safety purposes.

The Mux-Boxes in the Mux-Box racks are floating with respect to the rack frames or other local metal hardware. The Front End Boards are contained in metal boxes which are screwed to the Mux-Boxes. Thus, the Front End Board's **local ground** is one and the same with that of the associated Mux Box. The Front End Board may require several power supplies. Each supply voltage will come to it, along with its power return, via a shielded twisted pair with drain wire connected to the shield as shown in Fig. 2. Thus at the Front End Board, **local ground** (pc board ground plane), all power returns, and power cable shields are one and the same net.

Fig 3 shows low voltage power supplies at the Electronics Rack. Note that the return lines for these supplies **are not connected to the Global Ground** bar. The supply voltage cable shields (drain wires), however, **are connected to the Global Ground**. **Thus, the primary ground connection tying the Mux Box local ground to Global Ground is the power cable shield[2].** Since all supply return current flows through the return lines, and none through the shields, there is no voltage drop across the shields. Thus, the potential at the Mux Box Crates should be zero wrt Global Ground. For safety purposes, we need to guarantee that in the event that the low voltage cables are not plugged in at the Mux Box racks, the low voltage supplies do not float up too much from ground. This can be done by a safety diode circuit between low voltage return and global ground. These will be such that they will not be active in normal operation and not cause ground loops.

Signals between front end board and readout board will all be differential. There is only one analog signal which will be differential and the digital ones will be LVDS. The analog signal will be transmitted via shielded twisted pair with shield directly tied to ground at the Readout board and ac coupled to local ground at the front end board. Thus there is no dc ground loop. The digital LVDS signals will be transmitted on flat ribbon cable which may or may not be shielded. If shielded, the shield is directly coupled only at the Readout board end and ac coupled at the front end board. A shield may well be unnecessary and expensive for this cable and may not be used. In this case, the common mode range of LVDS receivers along with the zero potential difference between the two cable ends should guarantee reliable operation.

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[1] Much of this document is based on ATLAS global grounding policy and available through ATLAS notes

[2] We may want to consider a more substantial ground connection using a copper braid tied between Mux Box and Global Ground bar which follows cable tray to the Electronics Rack.

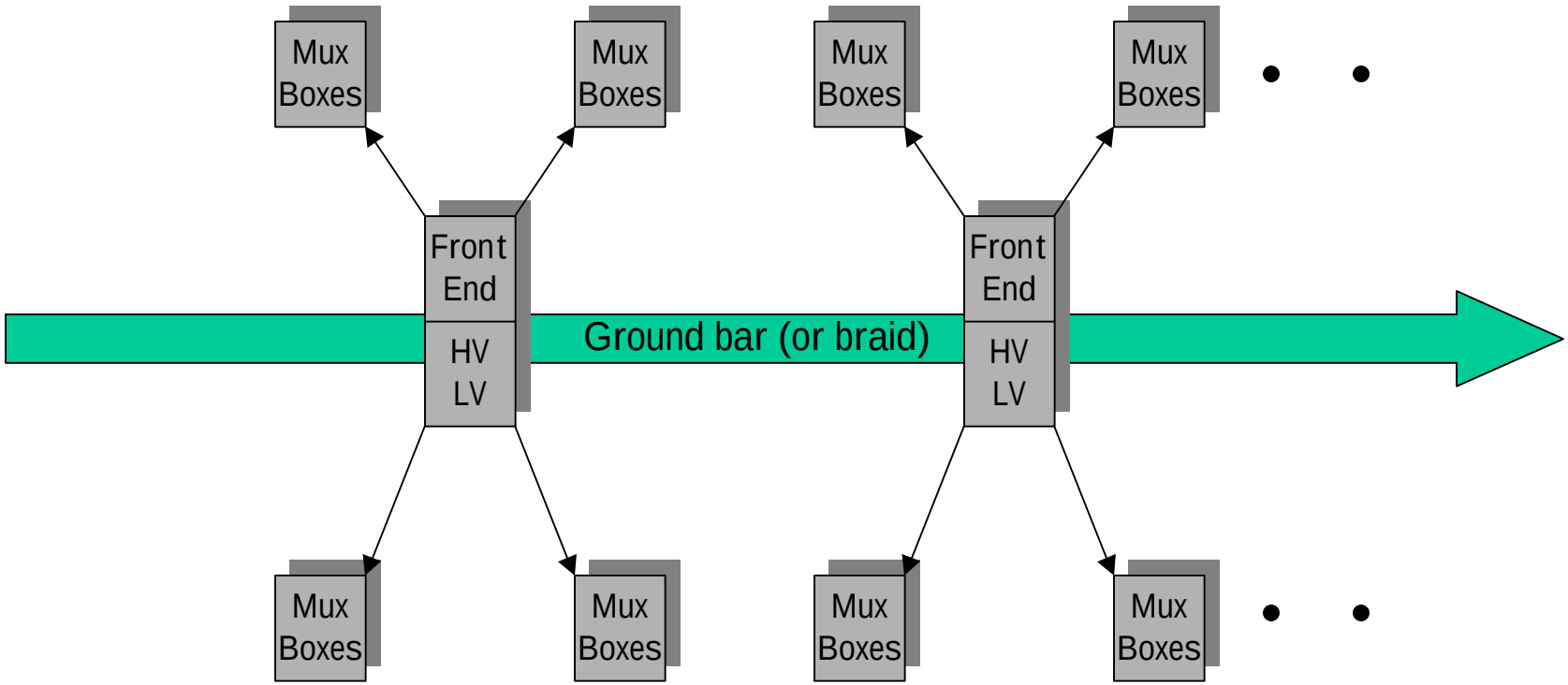
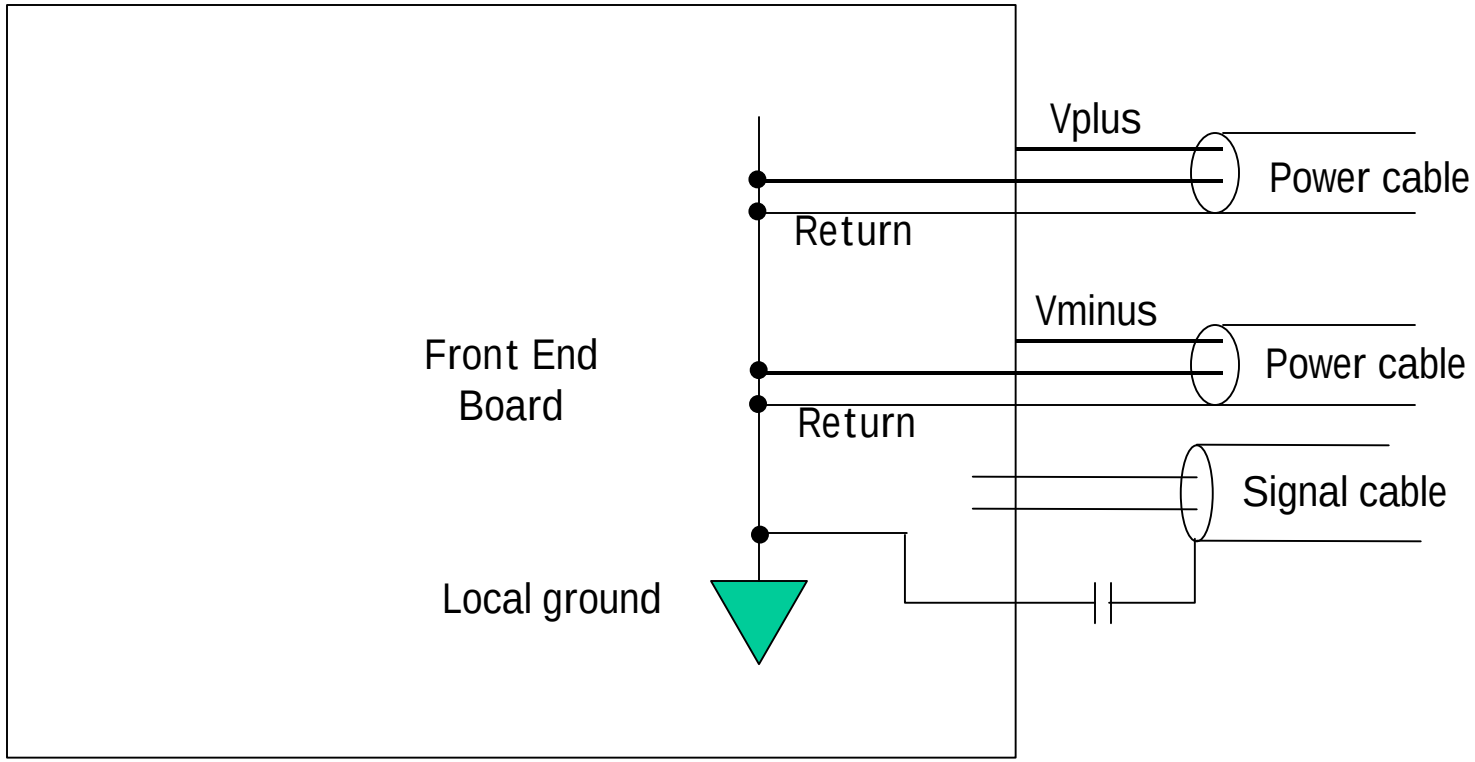
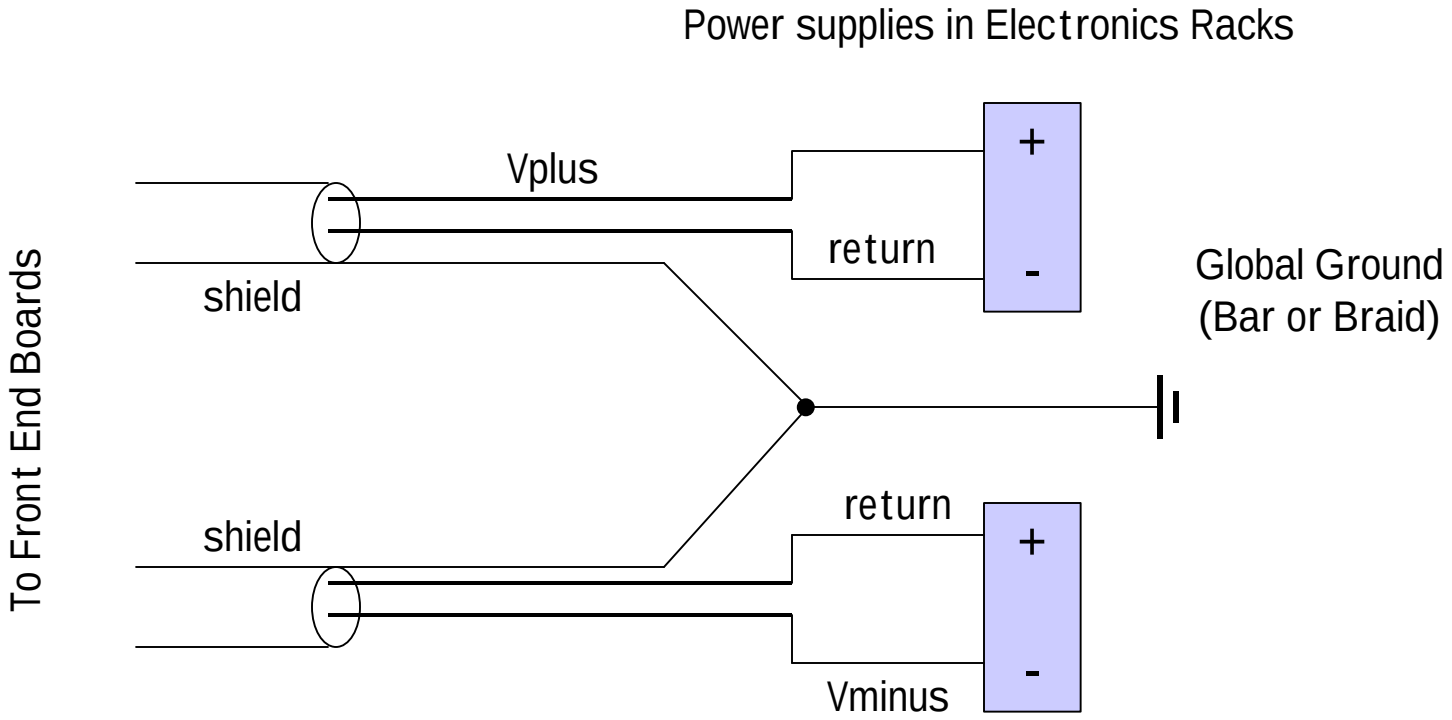
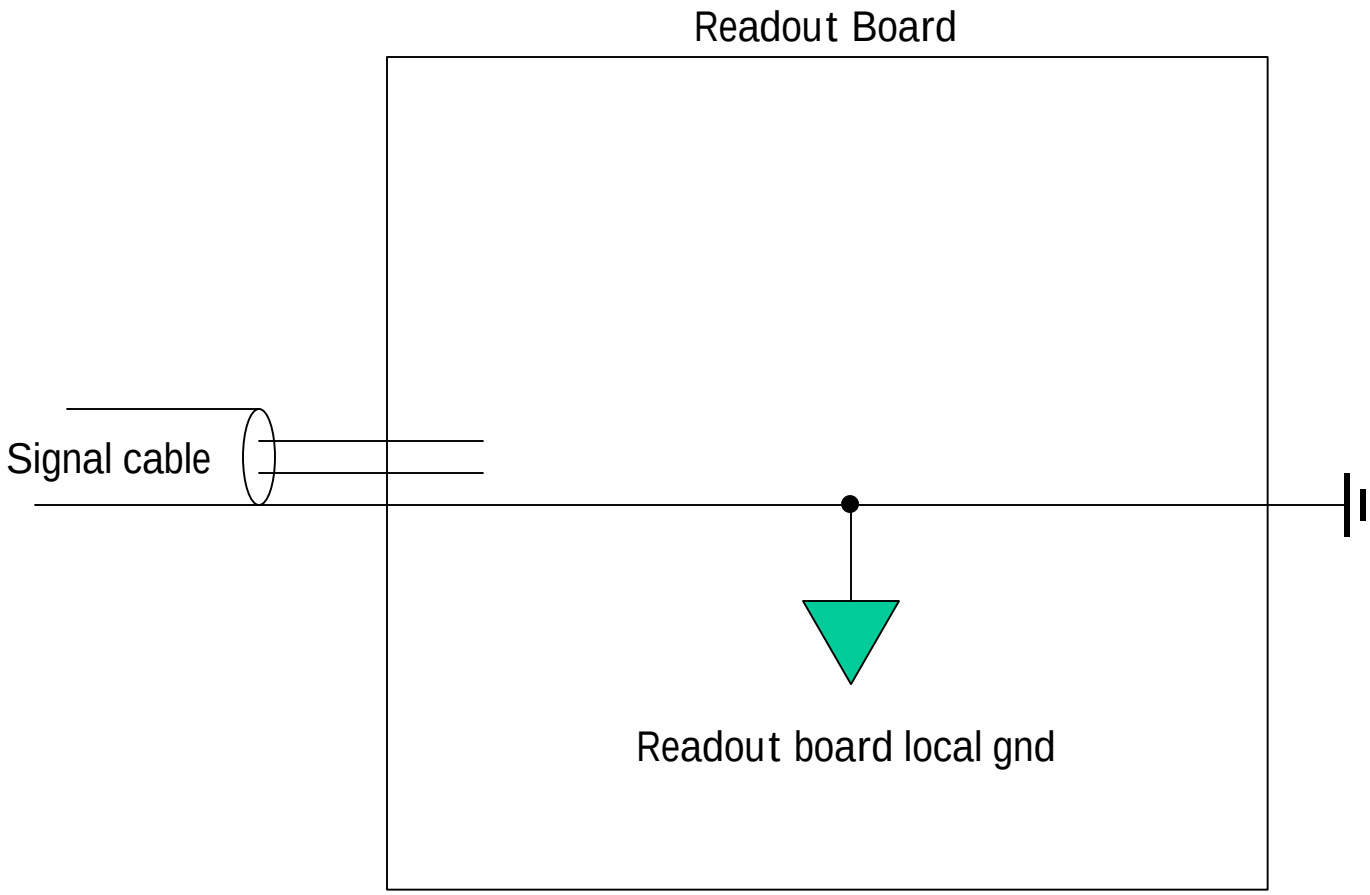

Mux Boxes
Mux Boxes
Mux Boxes
Mux Boxes
Front End
HV LV
Front End
HV LV
Ground bar (or braid)
Mux Boxes
Mux Boxes
Mux Boxes
Mux Boxes

Fig 1


Vplus
Power cable
Return
Vminus
Front End
Board
Power cable
Return
Signal cable
Local ground


Power supplies in Electronics Racks
To Front End Boards
Vplus
return
shield
+
-
Global Ground
(Bar or Braid)
shield
return
+
-
Vminus


Readout Board
Signal cable
Readout board local gnd

High voltage will be distributed from the hv supplies in the Electronics Rack along the same cable trays as the signal and lv supplies. The hv cables are assumed to be coax and thus single ended. In principle, one can break the ground connection at the Mux Box by using insulated SHVs and tying the SHV shell to local ground through a modest resistor of order several hundred ohms to 1 k ohm. This may or may not be necessary since even without this resistor, the ground loop created will be extremely tight, that is, very small in area since they use a common cable tray. I suspect the resistor connection will not be necessary but it may be prudent to reserve a place for it.

Finally, in order for this scheme to succeed, the following proviso needs to be enforced. **No additional ground connections for Detector Control, Calibration, or any other purposes may be made to the Mux Box local grounds.**